

BEDSIDE MEDICINE FOR BEDSIDE DOCTORS

An open forum for brief discussions of the workaday problems of the bedside doctor. Suggestions for subjects for discussion invited.

GLUCOSE REACTIONS AND THEIR PREVENTION

Alice F. Maxwell, San Francisco—The value of intravenous glucose solutions as a therapeutic measure has long been accepted and the method has been employed for a wide variety of conditions. In medicine the usefulness of glucose in acute infectious diseases, pneumonia, etc., cannot be overemphasized; the application of this treatment in surgery has demonstrated that nothing relieves postoperative shock, vomiting, and acidosis as promptly as glucose. Indeed many surgeons advise its use routinely as a preliminary and prophylactic measure in all major operative procedures. In the obstetrical field intravenous sugar has been most effective in controlling the acute vomiting and intoxication of pregnancy. In short the value of this procedure as a supportive measure in any medical or surgical crisis cannot be disputed.

Unfortunately, however, unexpected and unfavorable reactions occasionally follow its use, which may lead to most serious consequences and even fatal termination. It is generally agreed that these reactions are entirely preventable and depend upon errors in technique in preparation or administration of the solution. A discussion, therefore, of such reactions and their prevention should be of considerable interest to the medical person.

A glucose reaction is usually ushered in by a sharp chill followed by a sudden and often high elevation of temperature; later shock and mild or severe collapse may occur. Cyanosis and prolonged dyspnea have been noted. Autopsy examinations of several patients dying after intravenous glucose showed a thick sticky substance adhering to the heart valves. Impure commercial glucose from a tin can container was used generally in these cases to make the solution. Severe reactions following the use of commercial glucose are frequent. Improper preparation of the distilled water used as a solvent for the sugar, faulty sterilization of the solution, caramelization, rapidity of injection, temperature and concentration of the solution, the method of cleansing the apparatus for administering the sugar, are factors which are most important and must be scrupulously observed if reactions are to be avoided.

The following are a few general rules which should be followed in the preparation and administration of glucose solution.

Solvent—The glucose must be dissolved in freshly doubly distilled uncontaminated water. Salt solution or sodium bicarbonate solutions are not satisfactory. The distilled water should be used the day of distillation or sterilized immedi-

ately after distillation and kept sterile. If the distilled water is not immediately sterilized and kept sterile, a pyrogen resulting from bacterial growth will develop. This pyrogen is apparently a nitrogenous bacterial product which is not destroyed by sterilization and will cause a sharp reaction (chills and fever) if used. Distilled water of uncertain age and bottling should never be used.

Glucose—Chemically pure anhydrous glucose is necessary for intravenous therapy and is manufactured by several different firms. The importance of "chemical purity" on the label cannot be overemphasized, and preparations labeled "pure glucose" should not be used as a substitute.

Dosage—The average dose for an adult is one gram per kilogram body weight, and the appearance of sugar in the urine after 50 or 75 grams of dextrose simply represents the kidney spill and is not of great importance. A 25 per cent solution is a very satisfactory concentration, as its use is followed by more rapid and pronounced effects. The hypertonicity favors a more prompt interchange between the blood stream and tissues and therefore quicker utilization by the body. If larger amounts of water are required a 10 per cent solution may be used with safety; lower dilutions, however, are inadvisable, for many unfavorable results have occurred from the overloading of the vascular system with large amounts of a weak glucose solution.

The glucose should be carefully weighed into clean glass flasks and dissolved in the freshly distilled water. The solution should be filtered at least five times to remove all dust or foreign particles, the flasks plugged with cotton stoppers, sealed and sterilized by steam (one hour daily at 100 degrees C. for three days) or if in haste by an autoclave (thirty pounds pressure for one-half hour). The solution can be kept indefinitely provided it has been properly sealed. Solutions showing sedimentation or caramelization must be discarded.

The rubber tubing and glass connections needed to carry the solution to the vein should be carefully cleaned and sterilized. New tubing requires special treatment and before using must be thoroughly washed with running water boiled and finally autoclaved. The following suggestions come from the Sloane Hospital for Women, New York City: New rubber tubing should be soaked in soap and water for one hour; soaked for six hours in 4 per cent solution of sodium hydroxid, washed in running water followed by distilled water, and finally sterilized by autoclave.

The temperature of the solution is most important. A solution below 37 degrees C. or above

45 degrees C. will almost invariably result in a reaction. The rate of injection must be carefully calculated—it is essential that the solution be given slowly, one and one-half to two hours are required to inject 100 grams of glucose. This can be repeated every four to six hours without glycosuria.

Hospitals which are using a large amount of glucose intravenously for economic reasons usually prepare their own solutions. Ampoules of glucose carefully prepared are available and most useful. They are usually prepared as a 50 per cent solution and should be diluted only with freshly doubly distilled sterile water. If this is not available it is better to administer the solution without dilution.

To guarantee satisfactory results from intravenous glucose therapy these few rules must be carefully observed.

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Emile Holman, San Francisco—Doctor Maxwell's paper ably presents the important precautions to be used in preventing reactions following the use of glucose solutions intravenously. Attention should be called also to the work of Lahman and Moore, *Archives of Surgery*, March, 1927, who have shown that the normal ultramicroscopic emulsion of fat in the blood plasma may by various chemical and physical agents be broken "down," or the emulsion "coarsened" so that droplets of fat of a size capable of producing embolism are set free in the blood stream. They utter the warning that the physical state of the blood fat should receive consideration in every instance in which medicaments are introduced into the blood stream. A 10 per cent glucose solution was found to be one of the chemical agents capable of effecting such a coarsening of the emulsified fat. They counsel, therefore, that intravenous glucose should be administered when the plasma fat content is minimal—not immediately after a meal, nor it is conceivable, not immediately after an ether anesthesia which has the effect itself of breaking down the normal fat emulsion.

It would appear also that a 25 per cent solution might be more effective in breaking down an emulsion than a 10 per cent solution, and from other points of view it seems desirable to use a less concentrated solution. A 6 per cent glucose solution is isotonic with the blood, but there seems to be no harm in employing a 10 per cent solution of dextrose in an 0.7 per cent salt solution which is a better balanced solution from the point of view of ionization of the blood.

Doctor Maxwell does not mention the use of buffer solutions in preparing the glucose. Perhaps it is just as well that she does not do so. At one time much was expected from the use of phosphates to maintain the p_h of these solutions, but even with their use, reactions sometimes occur and it is probable that the very strict regard for the precautions Doctor Maxwell outlines will do more toward eliminating these reactions than the use of buffer solutions. Stoddard, however, in an article in the *Boston Medical and Surgical Journal* for December 11, 1924, states that since the use of 10 cc. of a sodium phosphate solution for each

liter of glucose solution no reactions from intravenous glucose have occurred. He considers it most important to use such a buffer solution even though its action may be entirely empirical.

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Andrew Stewart Lobingier, Los Angeles—This timely paper by Doctor Maxwell should receive the widest notice. The precautions laid down by Doctor Maxwell with such meticulous exactitude are of the utmost value. They are not usually observed, we venture to think, and the precision with which these measures should be conducted may find a slow acceptance by men who are fond of intravenous therapy but are unwilling to take the care which chemical conditions in the blood stream may demand.

Doctor Holman's suggestions following the work of Lahman and Moore on the emulsion of fat in the blood plasma is of the highest importance. In the days when chloroform anesthesia was more common, fatty change, especially in the cells of the liver, was the usual sequence of this anesthetic and in many instances was the probable cause of chloroform fatalities. As has been shown, prolonged ether anesthesia may be followed similarly by large fat globules in the blood stream, and the imminence of fat embolism may be a very serious menace. The suggestion that the fat content in the blood current should be known before glucose is given intravenously, is a wise precaution.

We have for a number of years used soda and glucose by proctoclysis to correct the acetone and diacetic acid which is often found present when the patient enters the hospital, and is usually present after anesthesia. Most patients are also dehydrated when we see them as subjects for surgery. It has been our practice for many years to prepare the patient for days before the operation by raising the fluid content and fortifying the patient against acetone and its evil consequences. As a result, vomiting, thirst, and other postoperative discomforts have been minimized and in most cases prevented entirely.

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Mott H. Arnold, San Diego—For some time it has been our practice to put the patients on an intensive diet of glucose, per mouth, prior to operative procedures, and I think we have gotten beneficial results, preventing acidosis, nausea, vomiting, and many uncomfortable conditions which often follow surgery.

Postoperatively we have had practically no bad effects or reactions following glucose intravenously. This no doubt is due to the fact that we have been particularly careful in the glucose that we have used. We have always used a chemically pure anhydrous glucose and prepared it with carefully distilled water, or with normal saline solution. With this we have always used a buffer solution. Our choice is a 5 per cent glucose solution, 500 to 750 cc. freshly prepared, sterilized in the autoclave, given at intervals of six hours and at least an hour or more to administer the solution. In our head cases we have used a 50 per cent solution, using from 50 to 100 cc., and have had no bad results.